FINER POINTS

"The ONLY magazine dedicated solely to the technology and application of superabrasives."

IMTS PREVIEW

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International
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IMTS 2006

September
6-13, 2006
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Chicago, IL USA

A Multi-Purpose Grinding Wheel For Many Materials

Milling Bimetallic Cylinder Block Deck Faces With Diamond

Calendar of Events

Hydrostatic Technology In CNC Tool Grinding Using Diamond Or CBN Wheels

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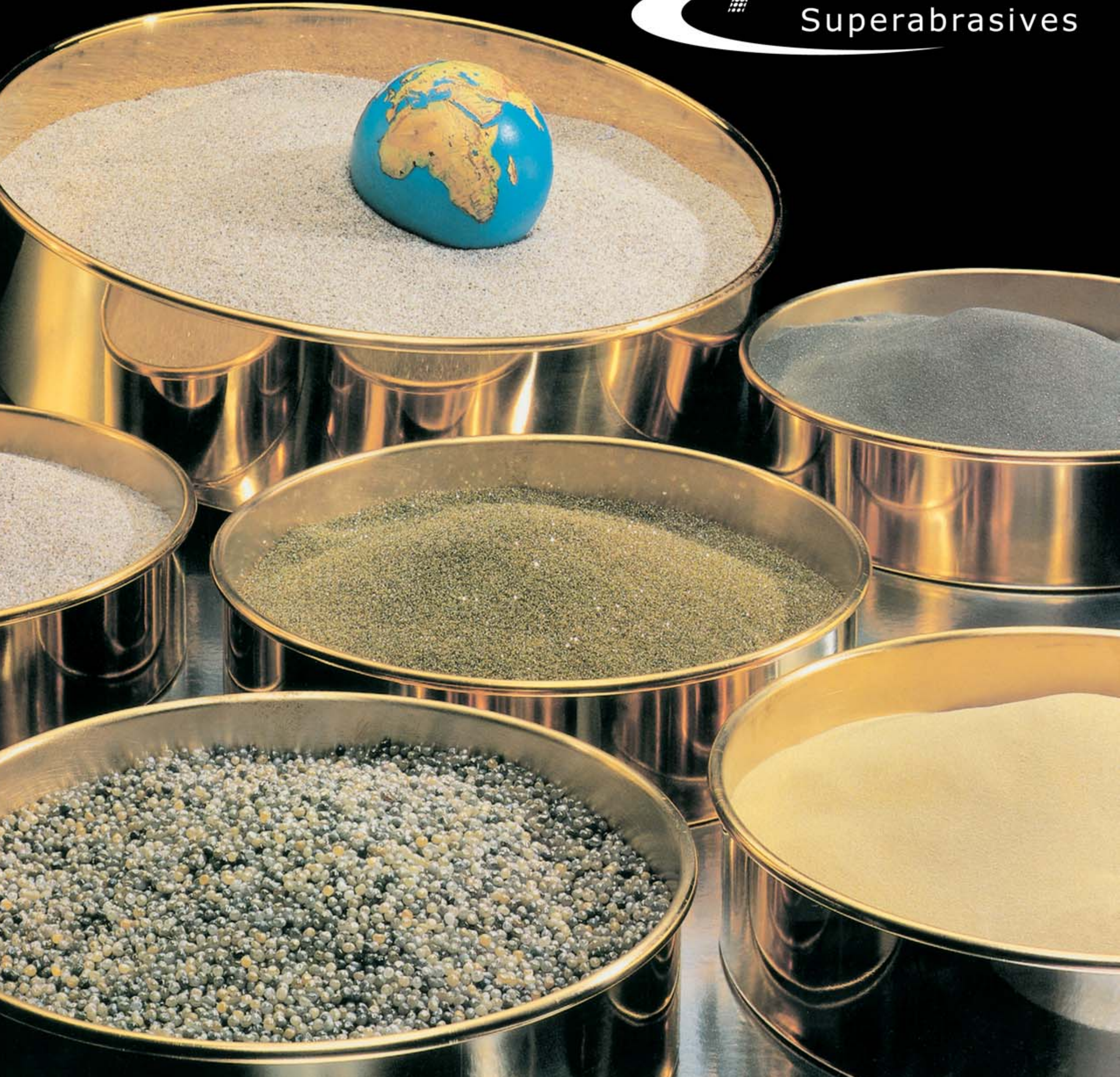

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1946 60th Anniversary 2006 Industrial Diamond Association of America, Inc.

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FINER POINTS is the only publication devoted exclusively to the understanding, selection and application of diamond, cubic boron nitride and related materials. It is edited for recipients who are involved in some way with these "superabrasives", either as providers of the materials, producers of products containing the materials or users of these products (e.g., grinding wheels, dressing tools, drill bits, saw blades, sawing wires, cutting tools, polishing compounds, CVD film products, etc.).

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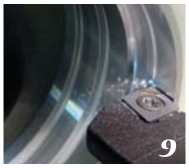

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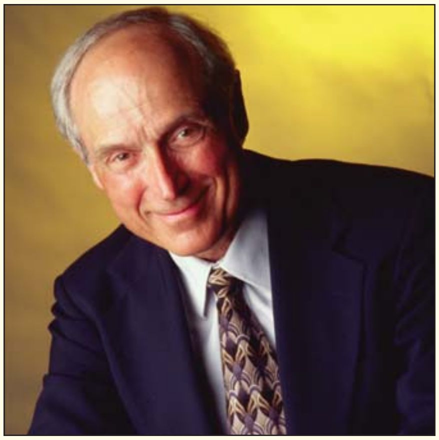
COVER PHOTO

McCormick Place, photo courtesy of Chicago Convention and Tourism Bureau. McCormick is the location as IMTS celebrates 79 years of Technology.

A Finer Point of View…

From Tape To Typing!



PRESIDENT
Robert Linares

For almost 80 years the International Manufacturing Technology Show, or IMTS to those of us who have done our share of "hall walking" over the years, has been the premier International show of its kind. From a superabrasive standpoint diamond made its appearance in the early 60's when manufactured diamond started making inroads in the grinding of carbide and glass. Another big surge came in the 70's when cubic boron nitride was hailed as the abrasive of the future. Like today, the main interest for visitors was still the machines. After all it was the "Machine Tool Show" even if abrasive technology was only conventional abrasives. Automation meant a combination of hydraulics and limit switches tied to a bulky external electronic recording and drive unit. The computer revolution was still in its early stages and numerical control was the big thing. As described at the time, it involved "adapting the principle of the electronic computer to design machines that could respond to instructions coded in number form on punched or magnetic tape and transmitted electronically to servo-mechanisms that operated the machine tool". Quite a lengthy description for what we knew as "automation" of the time. Still, machine tool builders embraced the "automation" and computer numerically controlled was a hot topic well into the 70's. Many articles and prognosticators hailed CNC as an "irrevocable commitment." Phil Geier Jr., Chairman of Cincinnati Milacron, predicted that by 1980, "a computer software system for full automation and optimization of all steps in part manufacturing would be developed and in wide use." He hit the nail right on the head. Computer systems now rule the industry and machines operate from programs and computer software not even dreamed of in the 60's and 70's. Of course it would be negligent of me not to point out the impact that superabrasives have made on the industry and this show. While diamond was the first and still the most influential of all superabrasives, the introduction of cubic boron nitride, polycrystalline cutting tools and most recently CVD diamond made their mark and helped elevate the machine tool technology to where it is today. Machine tool builders of the 2000's have committed to developing machines that take full advantage of the promise of superabrasives. This year when you "walk the halls" not only will you see EDM machines that cut and shape polycrystalline diamond, polycrystalline cbn and CVD diamond, but you will see machines that have taken abrasive machining to the next level. Today's machine manufacturers boast "designed" for diamond and cbn and they proudly display machines with enclosed high-pressure coolant systems, high speed operation, computer controls and automatic load and unload for maximum productivity. Many machining and grinding "centers" have multiple stations for machining, grinding, finishing and every other aspect of part production including self-dressing and in-process measurement. The only way these machines can be profitable is to be equipped with every possible type of wheel and cutter made with superabrasives. Profitability and increased production may have started with instructions coded in number form on punched tape with an aluminum oxide grinding wheel, but today it's typed on a computer keyboard to send a superabrasive wheel into a high speed operation!

Sincerely,

Robert Linares

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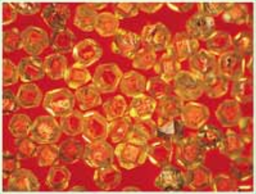

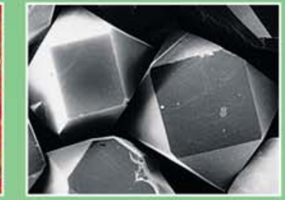

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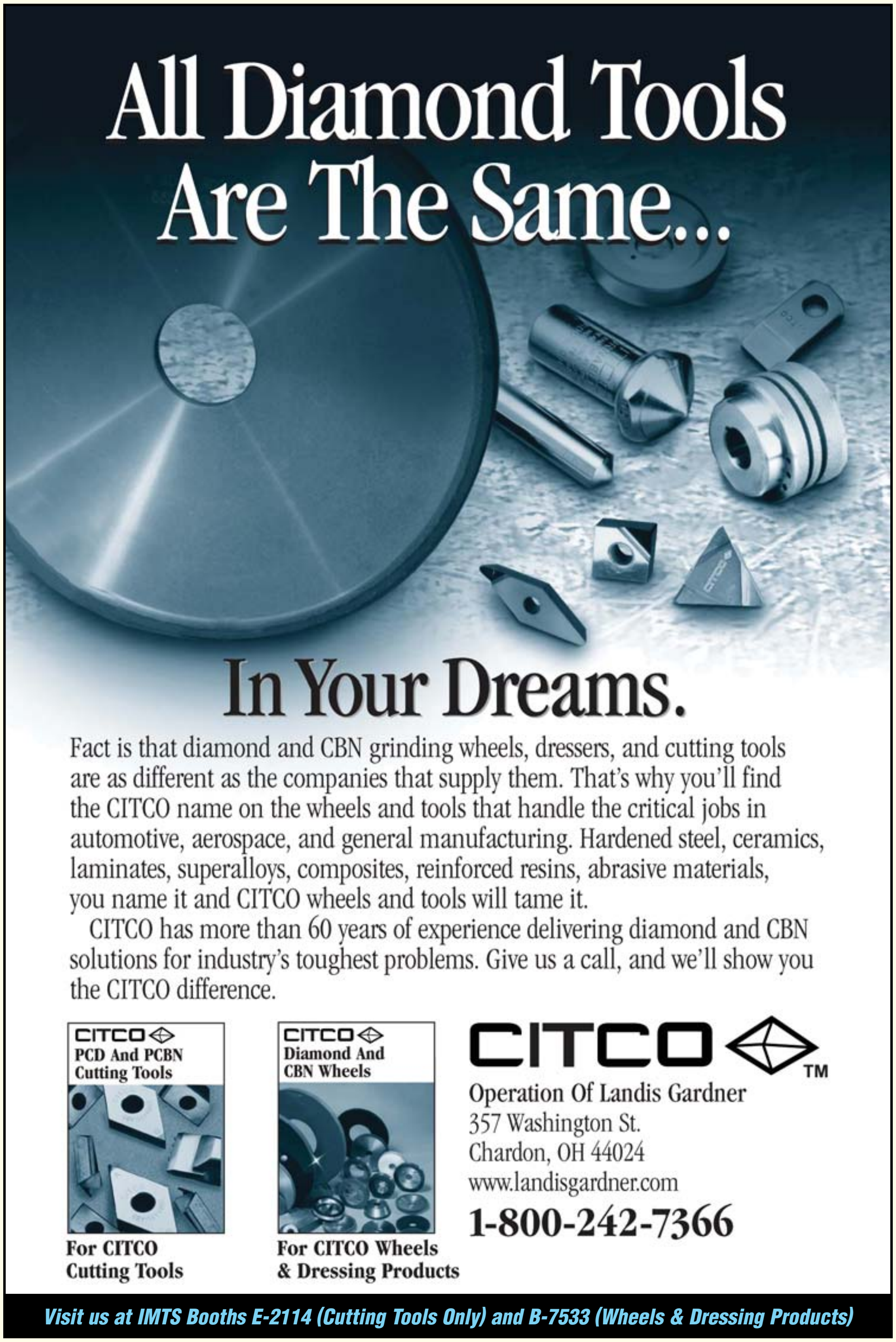
Editorial

Skilled Tradesmen A Dying Breed?

I officiate basketball, Ok, Ok, start your booing now and get over it! In the course of my schedule I travel from high school to high school around the state and the one thing that jumps out is the strong emphasis on going to college. There are college posters and dates listed for PSAT and SAT tests as well as consultants and tutors offering services to help students obtain those ever-important scores. Now I will grant you, having put three children through college it is a very satisfying and rewarding experience for a parent to see them get that sheepskin (are they still made of that?). But is college for everyone? I think not and maybe we should be taking a hard look at making sure all high school students know all their options. Talking with some youngsters, I see the outside pressure and influences on them to "go to college". Many have expressed their doubts or total disregard for college, much to the chagrin of their parents. Why don't educators push the trades? I think many times a school's credibility boils down to how many kids they put in the "higher education", ergo college, pipeline. But there are viable and important alternatives. I see the armed forces are always well represented at schools and their posters glamorizing service decorate the walls announcing dates recruiters will be on-site. If you watch the commercials on TV, they have done an excellent job selling the military. Of course a handsome young man or lovely lady in dress blues with a gleaming saber is not the first image of the service I remember! I will admit, seeing a valiant soldier slaying dragons and monsters like some video game hero has to be a big draw for today's X-box crowd! As another option, high school students need to be introduced to the value of the trades. Maybe the trade schools need to make as big a splash as the option of carrying a pack and hiking 10 miles. We constantly hear the lamenting over the lack of trained operators for the high-tech machinery of today. If attending IMTS this year one can only be impressed with the skill and expertise of the individuals running the machining and grinding centers. Where are these people coming from, it is the trade schools, is it in-house training? Trades of course cover a wider area than just machining and grinding. I read an interesting story about the typical person we used to call the jack-of-all-trades, especially in the building industry. The article pointed out that specialization (sound familiar) would see the demise of the multi-purpose handyman in the next 20 years. In fact the article actually used the term "dying breed". I dislike that term, because I find that many people will avoid these jobs rather than be classified as dying. Another study pointed out that licensing may be the answer, adding a certain prestige and recognition for the student. I am sure more certification, education and training will fill the need for specialized skills. Many trades and skills are being lost because there has been a collapse of apprenticeship training schemes in the past decade. In our industry, be it manufacturing or service oriented, there should be a push to train employees and increasing specialization will be the trend at all skill levels to meet the demand for future skills. Technology is driving this specialization and new careers should emerge in our industries that are not apparent today. Proper, and I emphasize the word "proper", certification should be implemented in our industry so not everyone can slap on a shop coat and call themselves a machinist or more importantly a supervisor!

TERRY KANE, Editor



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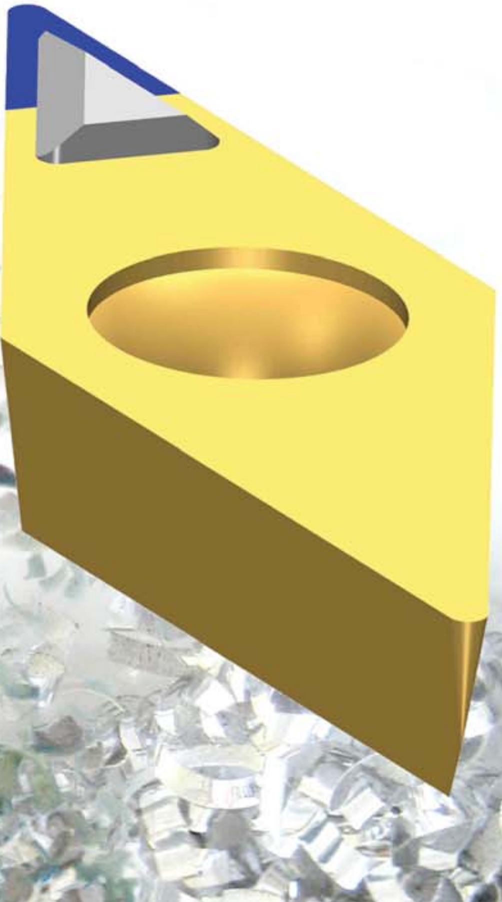

Announcements & PRODUCTS

RUSH MACHINERY INTRODUCES NEW DIAMOND / CBN WHEEL TRUING AND DRESSING MACHINE at IMTS 2006, in Booth #B7309. The Model FC-250W is designed for truing and dressing of flats, angles, and radii on diamond and CBN single wheels and multiple wheel packs. Use of the Model FC-250W allows for increased efficiency and accuracy by profiling, modifying profiles and truing wheels. The machine is simple to operate, quick, accurate and cost effective. **For further information, contact: Ted Hildebrant mail@rushmachinery.com**

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HOS-TECHNIK ANNOUNCES HIGH-TEMPERATURE RESIN FOR DIAMOND AND CBN GRINDING WHEELS

HOMIDE 250 is a pre-polymeric bismaleimide resin specially developed by HOS-Technik as binding agent for diamond and CBN grinding wheels. Thanks to its excellent thermal and mechanical properties, Homide 250 is different from other duroplastic systems. For example, Homide 250 has a low softening range (90 - 150°C/190 - 240°F), which means it can be processed and cured easily. A long-term temperature resistance of 250°C/480°F can be obtained with HOMIDE 250. It can also be heated up to 300°C/570°F for short periods without suffering any mechanical strength losses. HOMIDE 250 is handled in a similar way to conventional binding agents (e.g. Phenol). It is mixed into the other grinding wheels components as binding agent and pressed in a suitable mould at a pre-set pressure and temperature. As a rule, 20 – 30% resin (by weight) is used for this formulation. **For more details and a free sample, please contact: bdesrosiers@industrial-polymers.com or visit www.hos-tec.com**

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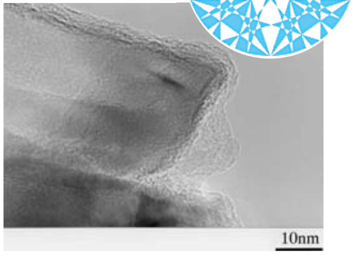

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St. Paul, Minnesota – 3M Abrasive Systems Division introduced high-performance diamond abrasive belts for grinding and finishing of thermal spray coatings and other hard to grind materials – such as ceramics, carbides and chilled iron – common in the aerospace, oil and gas, agriculture and paper manufacturing industries. Trizact Diamond Cloth Belts 663FC represent significant advances in abrasive technology, combining predictable dimensioning with ease of use, speed and finish consistency. The belts are constructed with microreplicated structures containing diamond abrasive mineral, coated on a durable, waterproof cloth backing. This unique construction ensures that fresh mineral is exposed through the life of the product, while maintaining a consistent level of cut and finish. By continually exposing fresh abrasive materials to the workpiece, Trizact Diamond Cloth Belts 663FC effectively “dress themselves,” resulting in consistent, efficient stock removal - without chatter - at a low grinding force. The predictability of 663FC belts makes the grinding process less dependent on operator skill and also allows the process to be automated more easily. **For more information about 3M Abrasive Systems Division, call 1-800-567-1639 ext. 5020 or visit www.3M.com/abrasives.**

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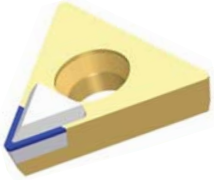
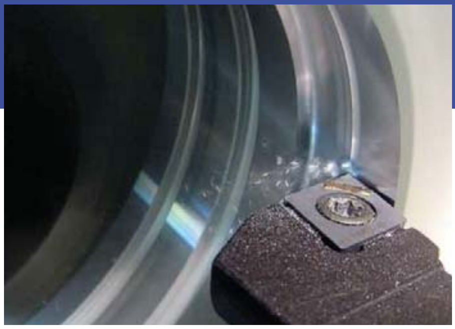
INNOVATIVE ALUMINUM MACHINING WITH LACH DIAMOND AT THE IMTS 2006 – CHICAGO – BOOTH E-2085

The LACH DIAMOND display includes newly developed PCD machining tools for innovative processing of aluminum. Foremost the unmatched PCD insert with an integrated chipbreaker. This high-tech product, especially in form of the enhanced processing of forged or drawn aluminum is a must for the automobile and accessories industries. The chipbreaker of this PCD insert breaks the chip immediately following its formation thus preventing the creation of the long and disturbing chips. The aluminum chips are easily removed and prepared for recycling. The **»dia-compact« monoblock diamond milling cutter** is used for face and square angle milling of aluminum parts for the automobile, electro industry and their suppliers.

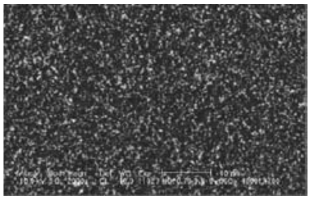


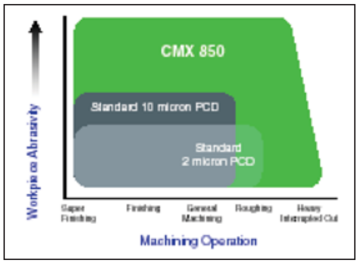


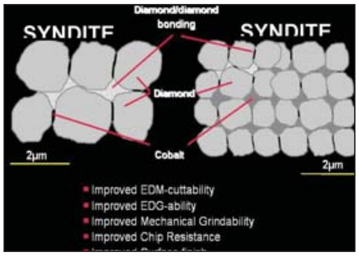
Diamond Abrasives Corporation

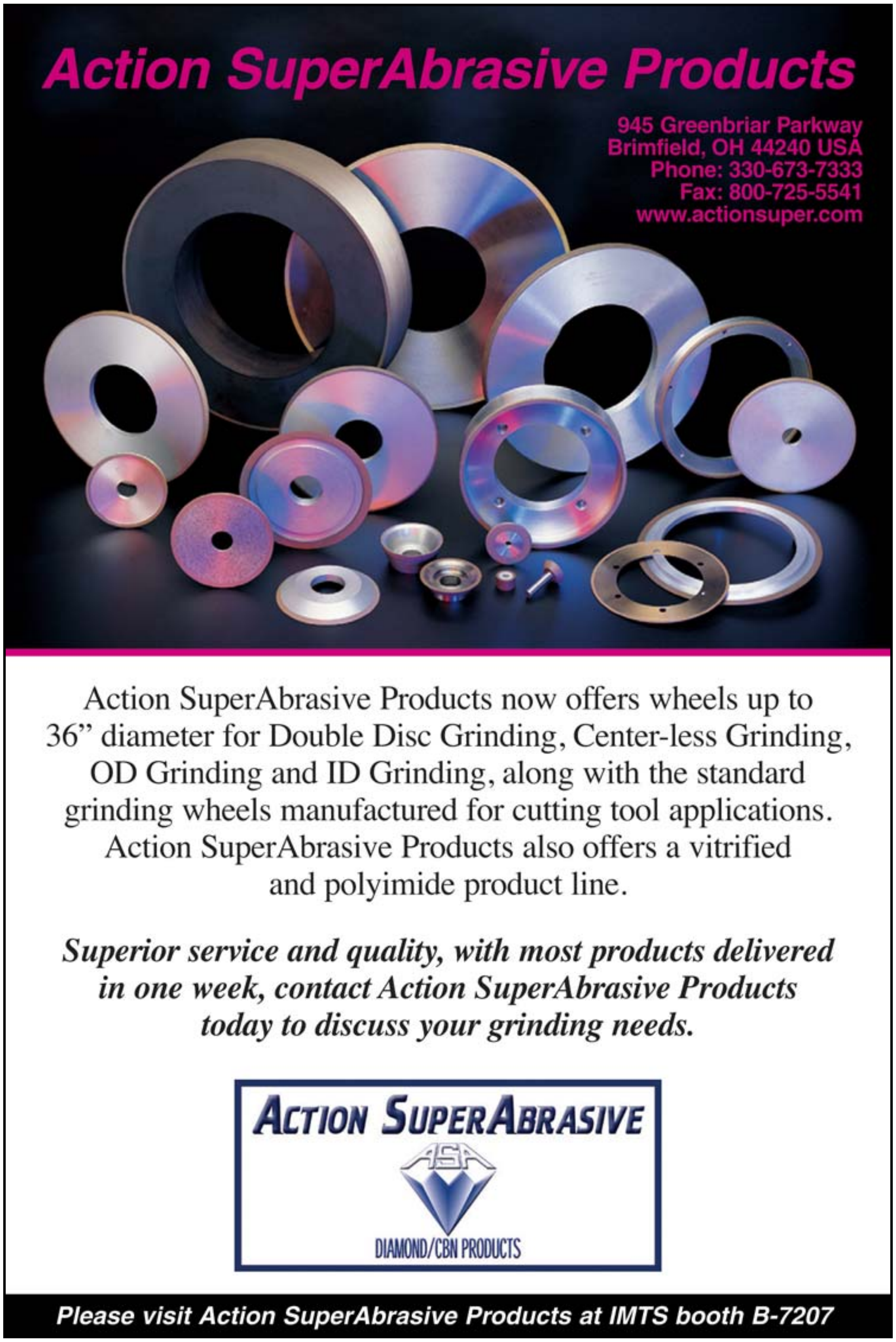
DIAMOND ABRASIVES CORPORATION ANNOUNCES NEW PRODUCT SYNDITE CMX850 – FINE GRAIN PCD

Syndite CMX 850 is a unique fine grain PCD cutting tool material which possesses an unrivalled combination of chip resistance, abrasion resistance and ease of tool manufacture. It is a high performance utility grade for many different and demanding applications in the aerospace and automotive industry. For example, in the aerospace sector, CMX 850 is ideal for milling and rough-cutting of Titanium and Aluminum alloys where there is a high demand for chip resistance yet, unlike other fine grain PCD materials, CMX is also suitable for machining Aluminum-Silicon alloys where the primary demand is abrasion resistance.





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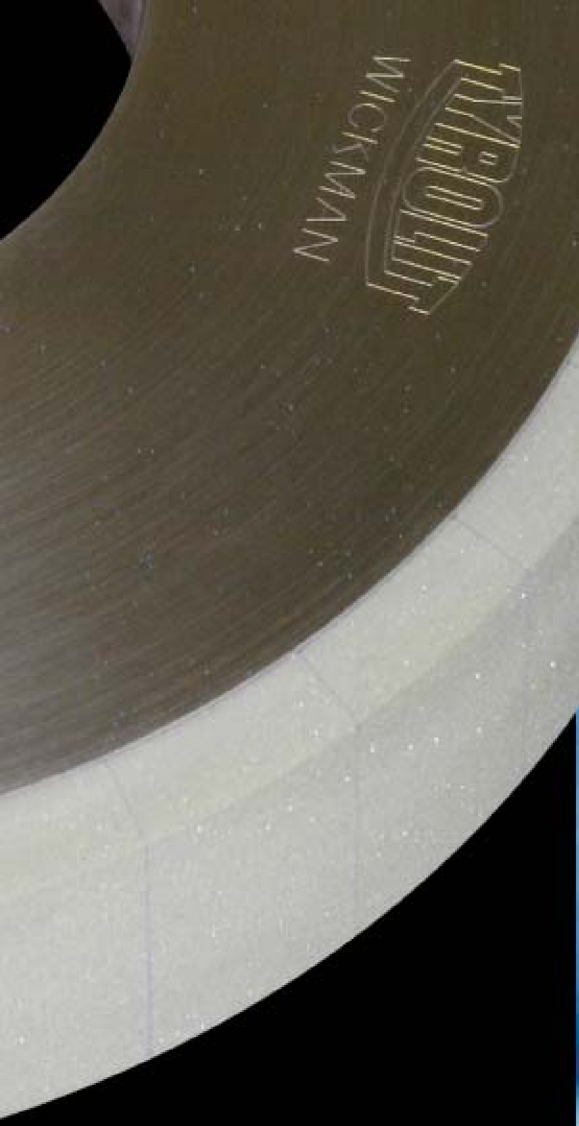

A Multi-Purpose Grinding Wheel For Many Materials

By Dr. Ambrish Reshamwala,
Tyrolit-Wickman Inc.

NEED FOR A GENERAL PURPOSE SUPERABRASIVE WHEEL

There are hundreds of Job-shops across the US & Canada who grind a wide spectrum of materials. These materials are hard & soft, ferrous & nonferrous, ceramics and carbides, glass and cermets, plasma sprayed alloys and superalloys. Often, the parts they grind are combination of these materials as composites. These job-shops are the backbone of manufacturing infrastructure. Like all others, they also face challenge of global competition. They are looking for ways and means for improving productivity and profitability. Productivity and profitability of a precision grinding shop depend on optimum use of the grinding machines, minimum trial and error time for selecting the right specification of the wheel, reduced dressing and truing time, reduced frequency of parts gauging and inventory of grinding wheels among other things. A new wheel (photo 1) shows the potential for grinding variety of metals and non-metals, individually and in combination. These wheels are capable of removing preset amount of material without frequently truing and dressing operations normally required. This is a multi-purpose wheel intended for those who are grinding materials in small lots. It is not intended for optimum performance. Therefore, it should not be compared with customized superabrasives.

Photo 1

MANY ABRASIVE TYPES FOR WIDE RANGE OF MATERIALS

The last couple of decades have seen exponential increase in the use of exotic materials. These are the materials with great resistance to wear, abrasion, corrosion, & temperature in addition to hardness, impact strength, toughness etc. Demand for lightweight, high strength materials have also encouraged development of composite materials. High tech sectors have forced the use of parts made by combination of materials with widely different mechanical and chemical properties. With this kind of development in engineering materials, fabrication technologies have also made big strides. Abrasive machining, which includes grinding and honing, has under gone many improvements. Availability of multiple abrasive grains has improved performance of grinding wheels and quality of finished parts many fold. However, the fact remains that the manufacturing professionals are faced with a tough task of selecting appropriate specification to grind variety of materials. This is not an easy task. Consequently, they are forced to keep a huge inventory of assortment of wheels and adopt a trial and error method of selecting a grinding wheel. These problems get further complicated when faced with grinding of complex parts consisting of combination of materials with widely different properties to a desired degree of finish. Therefore, it is natural that end users dream of a grinding wheel that grinds most of the materials individually or in combination without frequent change of wheels. In addition they hope that such a grinding wheel requires minimum dressing and truing. An experimental vitrified grinding wheel has been developed which is showing a potential for grinding a wide spectrum of materials. These wheels are self-dressing at a certain depth of cut and surface speeds, which is characteristic of the material being ground. At this stage there is no simple of way of predicting these numbers for each material. End user will have to find that out for their machine and parts being ground.

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MULTI-PURPOSE WHEEL THE ANSWER

Generation I of the multi-purpose wheel is a continuous rim vitrified wheel made on vitrified core. The following are examples of successful applications of this wheel.

Photo 2

Hammer spring -bank

The work on a multi-purpose wheel started several years ago when a manufacturer of high speed printing machine had a problem. Their product is called 'Hammer spring -bank', photo 2. This complex part is a composite of several materials: epoxy, aluminum, tungsten carbide, Inconel and steel. This manufacturer tried all sorts of wheels to grind this part, which took many hours to grind. Further, in order that part is functional certain geometrical relationships between various embedded inserts and aluminum casing had to be maintained. The new general-purpose wheel provided the solution.

Superalloys

Another user, who grinds superalloy castings on daily basis used to spend more than a month (8hr a shift) to grind a seven-part mold assembly. They tried various ceramic wheels, resin and vitrified bonded CBN grinding wheels but total time and cost savings was marginal. The multi-purpose wheel reduced the total grinding time by half. They dressed the wheel once a day.

Superabrasive hones

A manufacturer uses certain sizes of metal bonded super abrasive hones. These hones are very small and thin and required tight tolerances. The part consisted of diamond, bronze and steel. Grinding was the only method to achieve these tolerances. Before the multi-purpose wheel, 60% of hones were scrapped because they bowed during grinding and process time was too excessive. Ever since they started using multi-purpose wheels – scrap rate is almost eliminated and time to achieve the required tolerances is now acceptable.

Granite Surface Plate

Another example was on 24" x 18" granite surface plates to be ground flat within .0005". Normally, for this job a metal bonded diamond wheel and a Blanchard grinding machine are preferable. Instead a multi-purpose wheel was used on a surface grinder and the specifications were met.

These successful examples led to grinding tests with the multi-purpose wheel surface grinding on variety of materials. One manufacturer grinds variety of materials and composite materials. They agreed to test the multi-purpose wheel. They saved time for wheels changes, dressing and truing and lost reduced time for part gauging. The following tables show the parameters (Table 1) and results (Table 2) for the various materials ground.

MACHINE CONDITIONS - Table 1

Contact	Novak	Wheel type	1A1 Cont. rim
Machine Type	Surface Grinder	Wheel Size	12" x 1" x 5"
H.P.	6	Bond	VNX I
Spindle Speed	1800 RPM	Abrasive Size	120 /140
Coolant Type	Water Soluble		
Table Speed	130' / min		
Cross Feed	3/8" increment		
Down Speed	Various		

TEST RESULTS - Table 2

Material	Tungsten / Copper	Silicon Carbide	Steel / Carbide	4340 Steel	Sinter Metal –CPM3V
Part Size	5" x 2"	0.200 x 4"	3" x 15"	16" dia	6.25 x 2.5"
Pcs. / Set-up	2	48	1	2	12
Down Feed	0.0005"	0.0003"	0.0003"	0.0004"	0.0004"
Total Stock Removed	0.020"	0.030"	0.009"	0.030"	0.018"
Wear on Diameter	0.001"	0.0045"	0.004"	0.012"	0.018"
Hardness	Rc 3	N.A.	Rc 58 / Ra 8	Rc 40	Rc 58
Flatness	0.0002"	0.0002"	0.0002"	0.0003"	0.0002"
Finish	22√Ra	8√Ra	15√Ra	14√Ra	12.6√Ra

DRESSED WHEEL ONCE WHEN MOUNTED

Encouraged by these results, additional tests were performed and information was collected on numerous materials for possible application. The test parameters are shown in Table 3.

Results of these tests are on the following pages.

TEST PARAMETERS FOR ALL MATERIALS - Table 3

Machine	Okamoto Surface Grinder 12 -24DX
Wheel	VNX2-151- 1413 VR032W
Size	1A1S 12" x 0.5" x 5" -0.250" 'Alum.W' Core
Spindle Speed	1700 RPM (6800 Spam)
Table Speed	50 fpm
Cross Feed	0.100"

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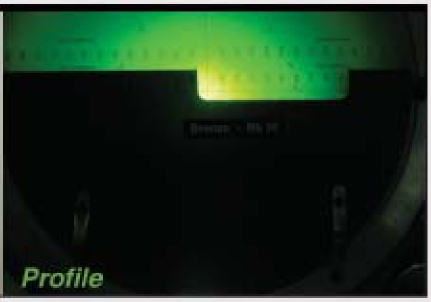
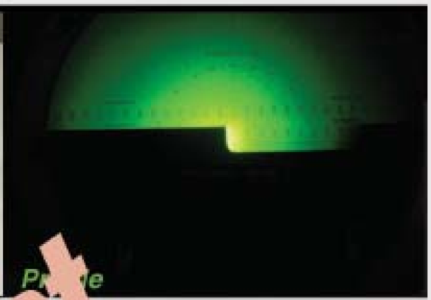
Surface Grinding
TEST RESULTS on BRONZE

The test sample had a hardness of Rb 35 with a 0.0015" depth of cut and the wheel held a corner radius of 0.30". The material had somewhat brittle, short ground chips.



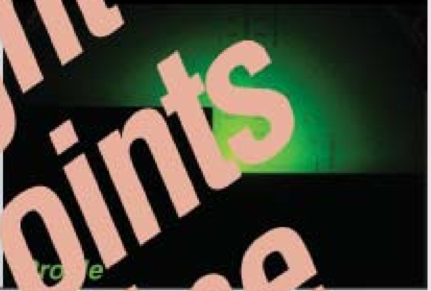
Surface Grinding
TEST RESULTS on 4140 STEEL

The test sample had a hardness of Rb 85 with a 0.0012"depth of cut and the wheel held a corner radius of 0.30". The material had somewhat stringy chips, very gummy.



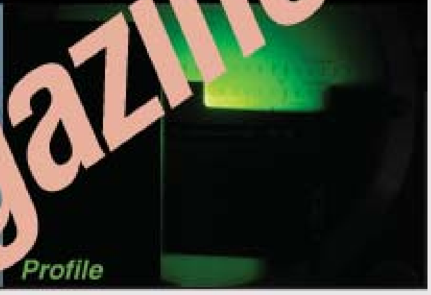
Surface Grinding
TEST RESULTS on 416 SS

The test sample had a hardness of Rb 94 with a 0.0015"depth of cut and the wheel held a corner radius of 0.10". The material had Stringy chips.



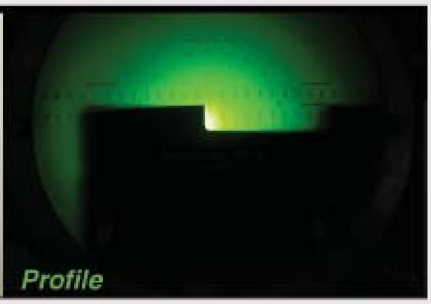
Surface Grinding
TEST RESULTS on D2 STEEL

The test sample had a hardness of Rc 66 with a 0.00125" depth of cut and the wheel held a corner radius of 0.020". The Tungsten carbide had powdery and short chips.



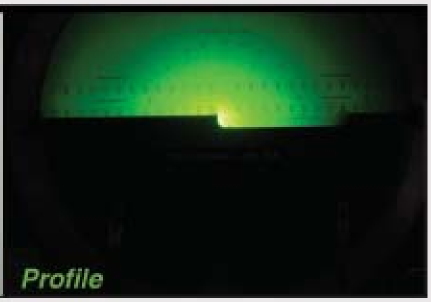
Surface Grinding
TEST RESULTS on TUNGSTEN CARBIDE

The test sample had a hardness of Rb 106 with a 0.001" depth of cut and the wheel held a corner radius of 0.030". The Inconel had stringy chips.



Surface Grinding
TEST RESULTS on INCONEL

The test sample had a hardness of Rb 108 with a 0.001" depth of cut and the wheel held a corner radius of 0.030". The Titanium +6% Vanadium had stringy chips.



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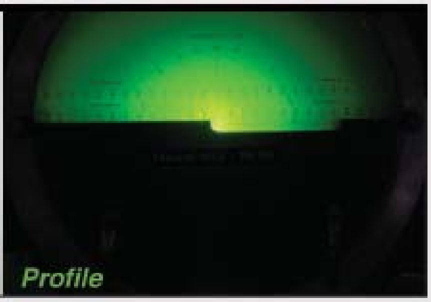
Surface Grinding
TEST RESULTS on TITANIUM +6% VANADIUM

The test sample had a hardness of Rb 108 with a 0.001" depth of cut and the wheel held a corner radius of 0.030". The Titanium +6% Vanadium had stringy chips.

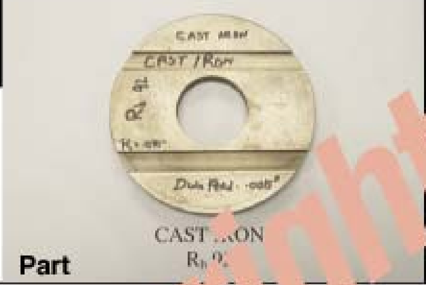
Part



Profile

Surface Grinding
TEST RESULTS on CAST IRON

The test sample had a hardness of Rb 92 with a 0.0015" depth of cut and the wheel held a corner radius of 0.010". The Cast iron had hard brittle, powdery swarf.



Part

Profile

Surface Grinding
TEST RESULTS on GLASS

The test samples hardness was not applicable with a 0.0015" depth of cut and the wheel held a corner radius of < 0.010". The Glass had powdery swarf.

Part

Profile

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SEGMENTED WHEEL TEST AT MANUFACTURER

Generation II of the multi-purpose wheel is a segmented wheel (Photo 7) made with variable porosity from 25 to 36% and is glued on resin, metal or vitrified cores. This wheel was run in a test on 413 Stainless with 12% Vanadium. This material had a hardness of Rc 60-62. Downfeed was 0.0008" per pass and the total material removed was 0.020" per part. There were 50 pieces per setup and the parts were a 3" Crescent moon shape. A final surface finish was held to 12√Ra. Parameters for this test are shown in Table 4.

TEST PARAMETERS - Table 4

Contact		Wheel type	1A1 Segmented
Machine Type	Chevalier FSG 2460TX SG	Wheel Size	12"x0.5"x5"
H.P.	?	Bond	VNX 2
Spindle Speed	6500sfpm (33m.s)	Abrasive Size	100 /120
Coolant Type	WSO Cimtech 95		
Table Speed	750 ipm		
Cross Feed	0.240" per pass		
Down Speed	Variable		

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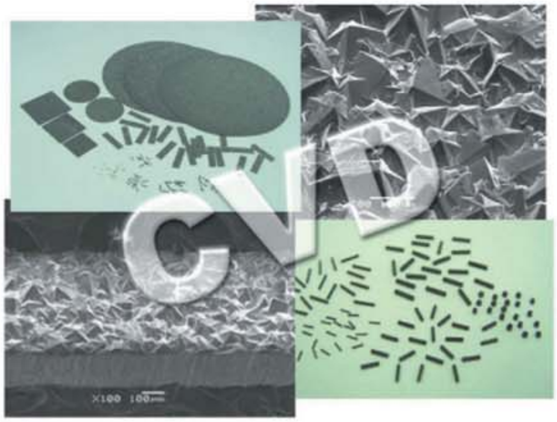

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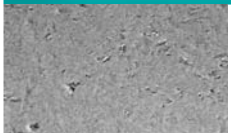

The wafers, manufactured by Advanced Diamond Technologies (ADT) and coated with ADT's Ultrananocrystalline Diamond™ (UNCD™), are available from Goodfellow in small quantities. UNCD is a family of diamond materials that have the hardness and other properties of natural diamond, but with a mirror-smooth surface that allows for outstanding control of surface properties. The mechanical and electrical properties of UNCD films can be tailored to suit specific applications. For more information, visit www.goodfellow.com or www.thindiamond.com

ABC Superabrasives **WARREN Superabrasives** **AMPLEX Superabrasives**

ABC SUPERABRASIVES CONSOLIDATES OPERATIONS WITH WARREN AMPLEX SUPERABRASIVES FACILITY

ABC Superabrasives, formerly located in Boca Raton, Florida has recently announced its relocation to 1401 East Lackawanna Street – Mid-Valley Industrial Park, Olyphant, PA. Warren Amplex Superabrasives – ABC's sister company – has been operating at the Mid-Valley Industrial Park facility since 1984. "It is our contention that this collaboration – manufacturing from one facility – Warren Amplex and ABC Superabrasives – will better serve its customers and markets. By increasing internal manufacturing throughput processes and concurrently eliminating bottlenecks - our production capabilities, distribution capacity and most importantly – research and development resources will be greatly improved. It is a business decision based primarily on manufacturing the finest surface conditioning product available to industry today," says Stig Washburn, Product Manager – ABC Superabrasives. Founded in 1945 – ABC Superabrasives have grown to be the largest independent processor and supplier of the complete line of today's Superabrasive products. Warren Amplex Superabrasives remains a world leader in uniquely designed and engineered diamond powder. Together, the two superabrasive companies will satisfy all the surface conditioning needs in industries like, optics, ceramics, aerospace, data storage, metal working and electronics. Both ABC and Warren Amplex Superabrasives are wholly owned subsidiaries of Saint Gobain-Grains and Powders. For more information visit: www.warrenamplex.com or email: abcsuperabrasives@saint_gobain.com

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Spring 2007	Superabrasives Resource Directory	Mar 31, 2006
Summer 2007	New Superabrasive Applications & Products	May 31, 2007
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Milling Bimetallic Cylinder Block Deck Faces With Diamond

By: Erik Koik, President and CEO Sp3 Diamond Cutting Tools, Inc.

Engine manufacturers striving for lower weight to improve fuel economy have adopted aluminum as the material of choice for cylinder block castings (Photo 1). However, aluminum cylinder bores can wear quickly in engine operation unless the blocks are cast with costly silicon impregnated bores. In response, die casters developed the technique of casting in thin liners made of cast iron that gives a durable bore surface without large penalties for weight.

The process is now the de-facto method for making lightweight engines. Automakers around the world, motorcycles, jet skis, outboard motors, lawn mowers, and almost any kind of power plant use this style of motor. Add to that compressors, pumps, and other equipment that uses the techniques and you will see that the market is huge. However, the product presents some real challenges to the people who have to take the castings and turn them into parts ready for assembly. The key area that presents a challenge is the deck face of the block (Photo 2). Typically, stock removal of .040" (1mm) to .080" (2mm) is required. The material can be abrasively machined by grinding or by milling. Grinding is expensive and manufacturing people looking to reduce costs have turned to milling. But success in milling has been elusive.

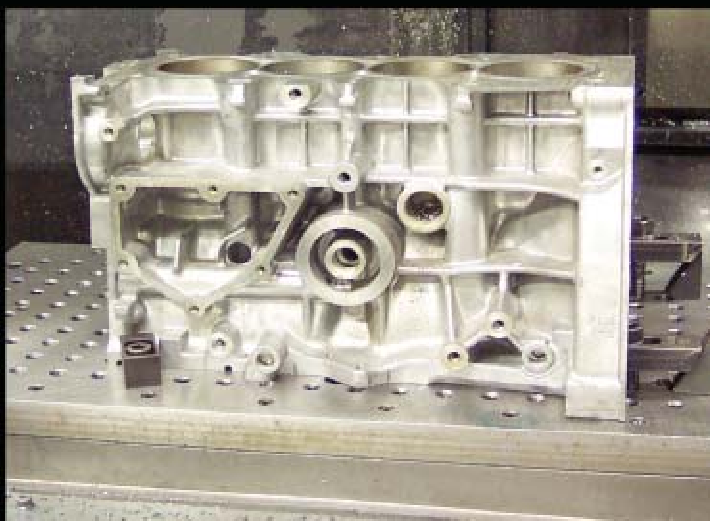

Photo 1 – Four Cylinder Automotive Engine Block

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There are two main problems to overcome.

- Cutting tool geometry, machining feeds and speeds, and cutting materials for aluminum and cast iron differ greatly
- The very action of face milling the materials as arranged can cause cast iron chips to be dragged by the milling cutter across the aluminum (sealing face) causing finish, flatness, and porosity issues

Because of the abrasive nature of the deck face area (silicon aluminum and cast iron), carbide is sub-optimal as a tool material. Typical tool life is counted in the hundreds of pieces. While the tools are cheap, the lost time in changing tools, presetting tools to be changed, and the like have a severe impact on productivity and cost. Additionally, if dedicated transfer machinery is used, the line must be stopped in order to change tools. Given that typical production rates are 100 engines/hour, tool changes can occur every two hours of operation. Thus, carbide as a cutting material is a poor answer. Diamonds seem to be the natural solution because of its inherent abrasion resistance, but diamond and cast iron don't mix. Or rather, they mix all too well when hot. The heat generated in cutting can cause the diamond to dissolve into the cast iron and quickly break down the cutting edge. Thus the abrasive resistance of the diamond is overcome by the destruction of the diamond in cutting. Additionally, traditional carbide cutting tool geometry tends towards positive axial geometry, thinning the cutting edge and making it even more susceptible to degradation.

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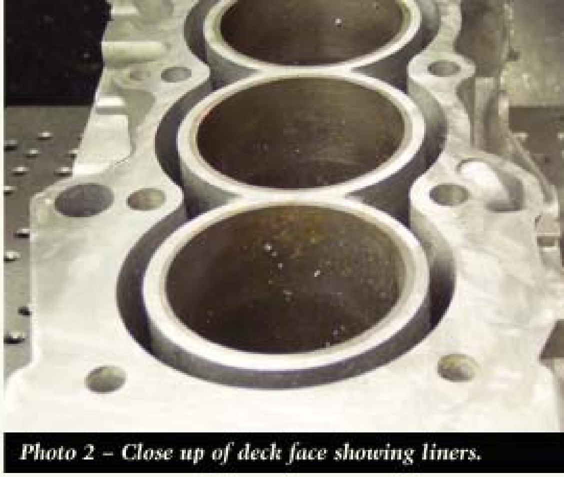

Photo 2 – Close up of deck face showing liners.

The keys to solving the problem in cutting tool geometry, machining feeds and speeds, and the differences in cutting materials for aluminum and cast iron are:

- Lower the cutting speed (surface footage) sufficiently to keep the diamond cool (<650sfm/183m/min)
- No more than .006" (0,15mm) chip load
- Use a cutter with the highest possible density of cutting edges to keep productivity high.
- Use an axially adjustable face milling cutter to ensure that each cutting edge is doing equal work
- Use the proper geometry to allow a strong cutting edge (neutral radial, 5 degree negative axial)

The keys to solving the fact that the very action of face milling the materials as arranged can cause cast iron chips to be dragged by the milling cutter across the aluminum (sealing face) causing finish, flatness, and porosity issues are:

- Managing the coolant to assist in chip clearance
- Using cutter geometry to assist in chip clearance

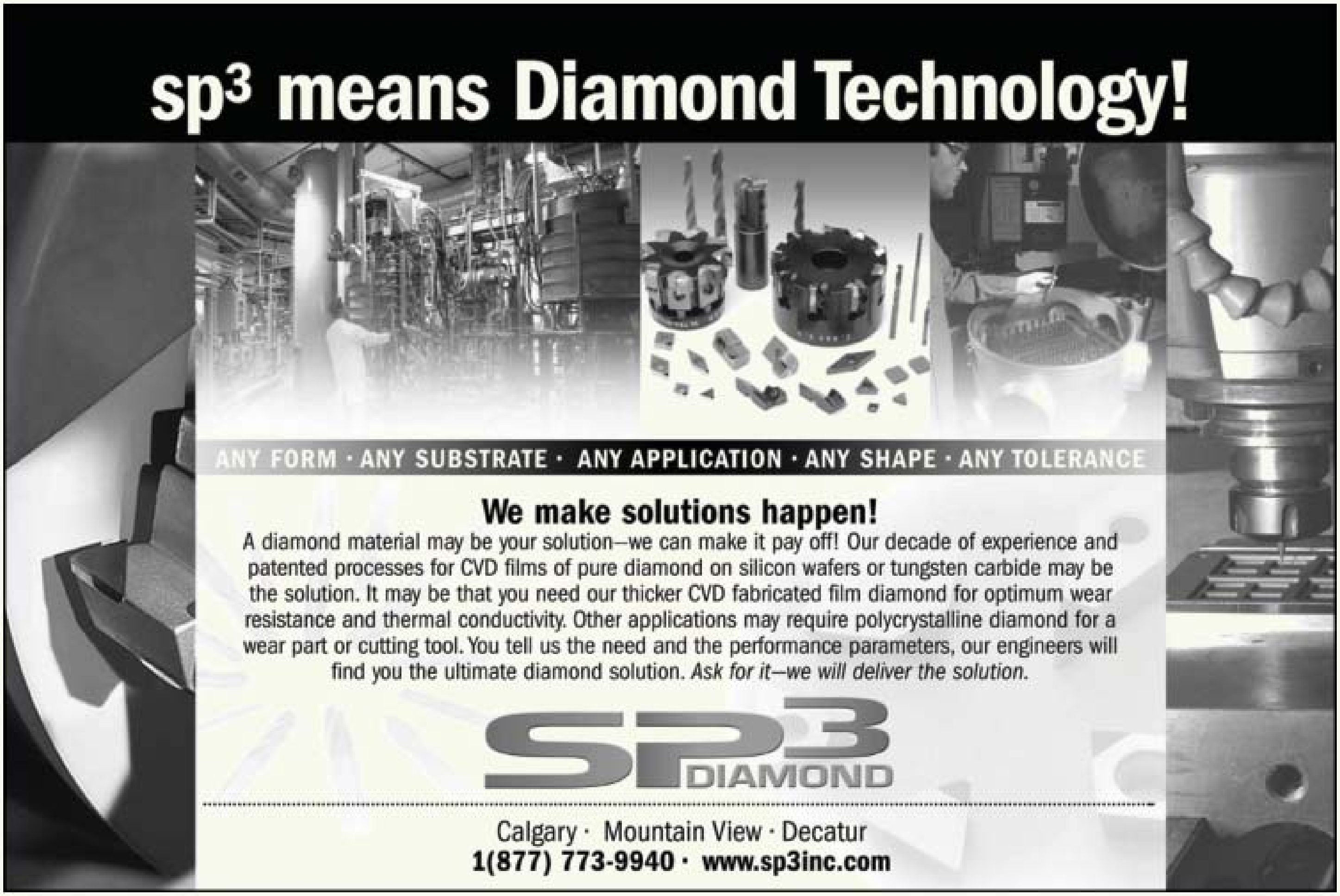

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Photo 3 – Scratches occur and flatness requirements are difficult to achieve.

The actual process used for machining the deck faces of these blocks is fairly straightforward. To minimize the amount of cast iron to be face milled, a simple counterboring operation is performed with a carbide tool at the top of each cylinder liner to remove cast iron leaving approximately .010" (0,25mm) of stock. There has been little success in machining both cast iron and aluminum with a depth of cut (DOC) of .040"-.080" (1-2mm), most likely because the volume of cast iron chips generated is too much to manage from a surface finish standpoint. There has been scratching on the aluminum deck face, which of course is also the head gasket sealing surface (Photo 3).

Once the counterboring operation is complete, the deck face (Photo 4) can be milled. This is accomplished in a single pass, roughing and finish in one cut. This final cut removes the .040"-.080" (1-2mm) of aluminum and .010" (0,25mm) of cast iron. In a typical example, an 8"(203mm) diameter milling cutter with 24 stations/edges can feed at 45"/1145mm/minute using 650 sfm/198m/minute as the cutting speed.

It must be emphasized that cycle time is not an issue. In the above example, on a typical 4 cylinder automotive engine block, the cycle time would be 20 seconds and thus not the pacing operation on a typical production line. The key to this is cutting edge density on the face mill. Get as many teeth into the job as possible. Another caveat is that a typical face-milling cutter using diamond inserts that are screwed down and located by a machined pocket in the cutter body are not suitable for this process. The tolerances of most diamond tipped carbide inserts are too loose, the locating pocket tolerances on the cutter body are too loose, and unless the cutter is axially adjustable, one insert or another will be doing the majority of the work, and will cause premature wear. Another issue with such cutters is that the inserts can move very slightly while in the cut and this will also lead to premature breakdown of

Photo 4 – Face Milling Operation

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the diamond cutting edge. Geometry as mentioned, is critical, but the suggested geometry beside assisting with chip clearance, also puts moderate pressure on the part in the fixture and aids by hiding porosity that is typical in die-castings, but hated by quality managers! Coolant is a critical element in the process. Through spindle coolant is REQUIRED, not optional. Flood coolant will not do the job. The coolant at the cutting edge helps keep the diamond cool and aids in chip evacuation. The coolant also helps to lubricate the cutting edge-to-workpiece interface. As mentioned earlier milling the deck face is a less expensive process than grinding and support can be given to that statement. First, grinding machines of the size required to grind a deck face productively, are very expensive to purchase. Capital costs are probably twice that of a machining center with the capability of counterboring and milling the deck face. Second, the grinding wheels themselves are expensive. While not quoting wheel prices, it is a fact that the face milling cutter in the example above costs $1600 to fill and will do 6,000-15,000 engine blocks before cutting edges must be replaced. Third, the chips or swarf from the milling operation are easy to manage, grinding slurry less so.

It should be mentioned that advances in die casting technology are coming rapidly. Blocks are now seen with cast in liners that eliminate the need for the counterboring operation completely, as the liners are positioned so as to give the proper .040"-.080" (1-2mm) of aluminum and .010" (0,25mm) of cast iron required for success. The upside to that is that even if equipment is purchased to do the primary machining operations described above, if casting advancements eliminate the need for counterboring the cast iron it can still be used for deck face machining. ■

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To summarize, though it's somewhat counterintuitive to think about using diamond to machine cast iron, in this application where abrasiveness is very high, and requirements for productivity, surface finish, flatness, and porosity are all tough to meet, diamond (Photo 5) is a proven, sensible way to solve the dilemma.

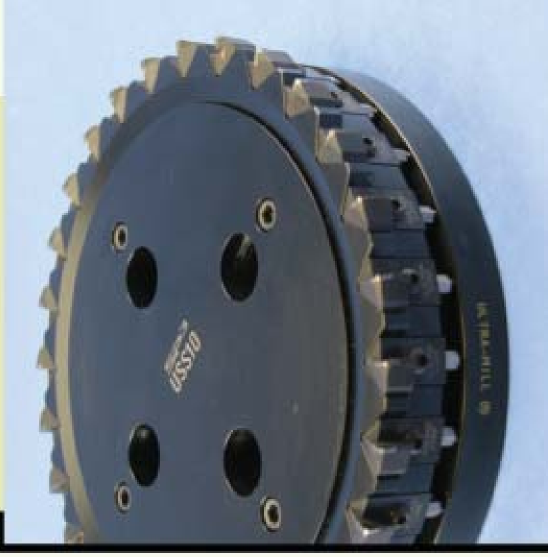

Photo 5 – Diamond cutters as a proven solution.

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Nanotechnology and Manufacturing Event
Pollard Technology Conference Center
Oak Ridge, Tennessee USA
www.sme.org

IWF 2006 Atlanta, GA USA

August 23-26
International Woodworking Fair
Georgia World Congress Center,
Atlanta, Georgia USA

DIAMOND

September 3-8, 2006
17th European Diamond Conference
Estoril Congress Center
Estoril, Portugal
www.diamond-conference.elsevier.com

International Manufacturing Technology Show
IMTS 2006
September 6–13, 2006 McCormick Place Chicago, IL USA

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Chicago, IL USA
www.imts.com

SME Society of Manufacturing Engineers

September 18-20, 2007
GREAT LAKES 2007
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conference and exposition
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USAwww.sme.org

September 18-22

International Machine Tools Exhibition
Exhibition Centre
Brno, Czech Republic
www.bvv.cz

AMB 2006

September 19-23
International exhibition for metalworking
Stuttgart Trade Fair & Convention Center
Stuttgart Germany
www.messe-stuttgart.de

OEM New England

September 20-21
OEM New England
DCU Center in Worcester,
Massachusetts USA
www.canontradeshows.com

October 2-4

SME Motorsports Conference & Exhibition
Charlotte, NC USA
www.sme.org

W6

October 8-11
Working With Wood Machinery and Equipment Exhibition
NEC Birmingham, UK
www.w6exhibition.com

MWC

October 10-13
Metal Working China 2006
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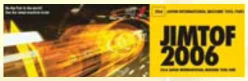

November 1-8
JIMTOF
International Machine Tool Fair
Tokyo International Exhibition Center
www.jimtof.com

Concrete Sawing & Drilling Association

November 2-3
CSDA Cutting Edge Training
November 4
OSHA Construction Safety Training

November 6-7
CSDA Estimating Course
St. Petersburg College Clearwater, FL
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AEROSPACE TESTING EXPO2006 NORTH AMERICA

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Anaheim Convention Center
Anaheim, CA USA

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October 31 - November 2
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www.sme.org/fabtech

CALENDAR EVENTS for 2007

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January 22-26, 2007
Las Vegas Convention Center
Las Vegas, NV USA
Tel: 866-962-7469
www.worldofconcrete.com

AEROSPACE TESTING EXPO2007 EUROPE

March 27-29
New Munich Trade Fair Center, Germany
www.aerospacetesting.com

April 19-20 2007
Diamond at Work
Rome, Italy
www.diamondatwork.com

APRIL 22-23, 2007
Industrial Diamond Association of America
Annual Meeting
Aladdin Resort & Casino
Las Vegas, Nevada USA
www.superabrasives.org

INTERWIRE TRADE EXPOSITION

May 5-10, 2007
Interwire 2007
I-X Center, Cleveland, Ohio, USA
www.wirenet.org

CALENDAR EVENTS for 2008

FEBRUARY 2008
Industrial Diamond Association of America
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www.superabrasives.org

INTERTECH 2008
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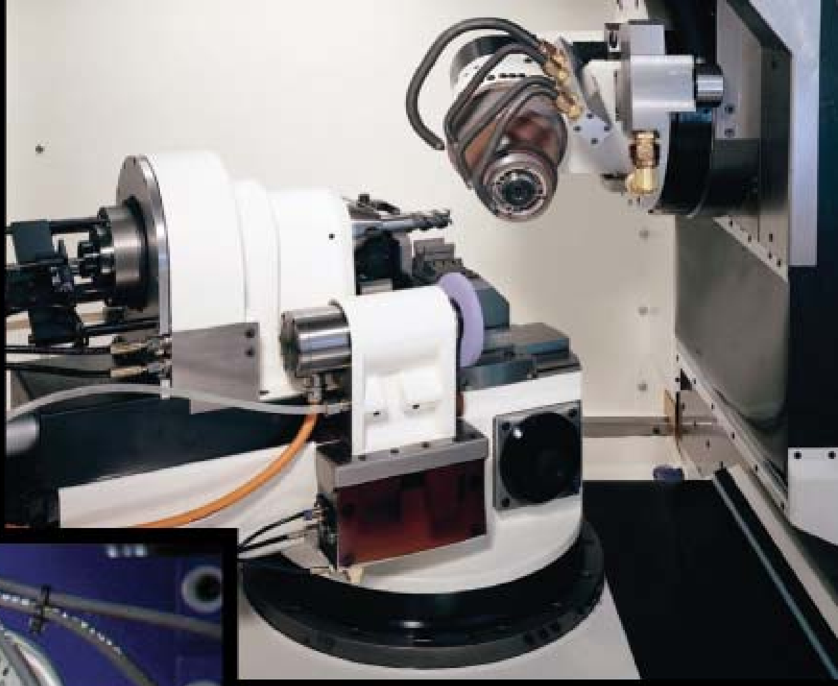
Hydrostatic Technology In CNC Tool Grinding Using Diamond Or CBN Wheels



By: Eric Schwarzenbach, Rollomatic Inc.
Pierre Pahud, PhD Engineering, Rollomatic SA

Purpose of a Fully Hydrostatic System

Photo 1 – Hydrostatic System

The required performances on cutting tools created by the advances in high-speed cutting and in hard milling are continuously rising. Concentricity and accuracy of the cutting properties are reaching levels that are increasingly difficult to meet with standard tool & cutter grinding machines. The goal in designing new machine tools is to try to increase precision, reliability and productivity. Quality demands are getting higher and that means for example higher accuracy. Productivity (machine) and quality (tool) are usually contradictory goals, but one new technology can solve both problems, which is the "fully hydrostatic technology". Super-precision tool grinders have traditionally focused on small tools. To obtain the same accuracy features from a machine for large cutting tools in the region of 1" diameter or larger (Photo 2), an innovative way of designing a new generation of machine tools had to be found. A traditional and obvious weakness in any machine tool is the fact that linear guide rails and rotary bearings use ball and roller bearings that have concentrated loads at the contact point. They offer only non-linear stiffness. "Fully hydrostatic" technology provided the answer for this with better distribution of load through infinite contact points created by the molecules of a thin film of oil. "Fully hydrostatic" technology provides no friction, no contact and no wear with 10 times higher damping and super high stiffness. In order to obtain a perfectly precise trajectory during 5-axis tool grinding, all guide rail system, all the rotary axes and the grinding spindle need to be developed with the hydrostatic bearing system in place of the traditional ball bearing type guiding methods.

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Photo 2 – 1-1/2" Cutting Tool

Cause And Effect Of Damaged Cutting Edge

Machine tools commonly have an "excitation frequency range", also known as the harmonics of the machine. Vibrations on the grinding machine can be compared with chatter on a milling machine. The damage on cutting edges (Photo 3) is usually caused by excessive vibration and bad wheel performance. A stiffer machine with higher damping ability will both improve the cutting edge quality

BENEFITS OF A HYDROSTATIC GRINDING SPINDLE

Cost Per Tool

Because of high stiffness up to 30% higher stock removal can be achieved compared to traditional systems, such decreasing the cost per tool without sacrificing quality and wheel life.

Surface Finish and Cutting Edge

10 times more damping compared with traditional systems give much better surface finish and therefore sharper cutting edges (much less chipping for carbide tools).

Wheel life

Much higher damping also means less sticking and reduced wheel wear, giving a much more stable grinding process with less production interruptions for wheel dressing and size corrections.

No Wear = No Maintenance:

Through the non-contact and friction-free guiding elements, the slides and rotary axes will never wear. The machine performance will never deteriorate or change over time, regardless of how hard, fast and how long the machine is used. This also means less interruption for maintenance and reduced cost.

Machine Stability

The hydrostatic oil is chilled and temperature-controlled and therefore has a cooling effect on the entire machine. This makes fully hydrostatic machines more thermally stable, which together with the use of chilled coolant oil, gives the perfect combination.

Tool Geometry

Errors associated with rolling element bearings are eliminated by hydrostatic ways. The straightness of axes movement is improved considerably, giving more accurate interpolated trajectory. This results in perfect tool geometry.

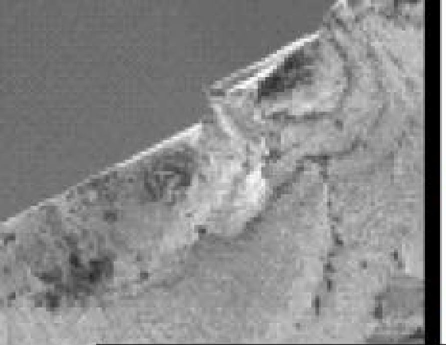

Photo 3 – Edge Damage

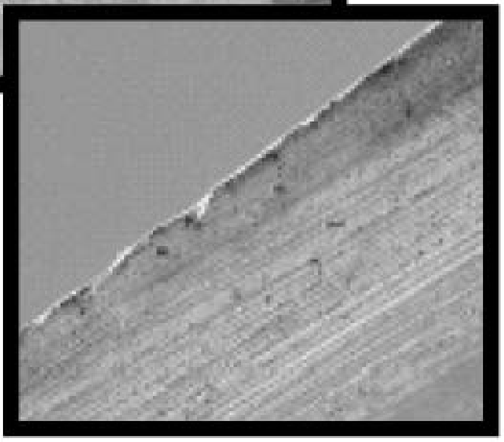

Photo 4 – Good Edge

(Photo 4) as well as wheel performance, which in turn will assist in obtaining a higher edge quality. Premature bond erosion and lack of edge retention are partly the result of insufficient damping on the machine.

Surface Finish On Cutting Tools

The Ra parameter is the most commonly used measurement for surface roughness in grinding and machining applications in the US. Until recently, in fact, it was the only parameter recognized by ANSI, although new ANSI and ISO standards include many different parameters from which to choose. Ra is the arithmetical mean roughness of a surface and is expressed in height. In the Imperial (English) system, Ra is typically expressed in "millionth" of an inch. This is also referred to as "micro-inches". In the metric system, Ra is expressed in millionth of a meter or microns. For measuring cutting tools, "skidded" gages are recommended. On this type of gage, the diamond tip stylus is contained within a probe that has a metal skid that rests on the workpiece. Another important factor in measuring and expressing Ra average roughness is the "cut-off" length. The cut-off length is expressed in distance (common available distances are .010", .030", .100" etc). This distance is multiplied by 5 times to arrive at the total distance at which the diamond stylus travels over the entire measuring lengths (Photo 5). For the final calculation of the Ra, each section is computed separately, and then averaged out one more time over 5 sections for the final Ra number. On a cutting tool, the chip formation takes place on the flute face as well as the primary relief angle. These two surfaces are generally used for surface finish determination.

How Does Hydrostatic Technology Work

There are no contact elements such as balls or rollers in bearing elements, as one would traditionally find in linear guides. Instead, hydraulic fluid is pressed into a gap with extremely high pressure in order to create a film of oil on which the upper part of the slide can "float" (Photo 6). The hydrostatic pad is mainly made of a pressure source connected to a pocket through a flow restrictor, which may be capillary, turbulent or pressure dependant type. The pocket is limited by lips, which are acting as a second restriction. According to the principle of conservation of the mass flow, pressure will be generated in the pocket allowing the lift of weight and the constitution of a fluid film separating the two surfaces. There is no more metallic contact and the weight can be carried without friction or wear. Hydrostatic guideways are used for linear and round movements in machines. The slide is firmly maintained in one direction between a pair of pockets. By control of oil pressure and the flow to the pockets, high loads can be tolerated and very high stiffness can be reached. In order to suppress five degrees of freedom to a carrier and ensure a CNC controlled sixth driven movement, a minimum number of five pairs of bearings are needed. For symmetry reasons, 6 pairs (12 hydrostatic pockets, photo 7) per carriage are often used. The friction is related to the shear of the oil film and is almost zero. This allows incredibly heavy slides to be moved by hand and/or slow and very small moves to be achieved. Inherent with ball and roller guideways, the reversal step of the friction force known as "stick-slip" or "static friction" does not exist in the hydrostatic system. When the machine is turned on, a hydraulic pump supplies oil to the hydrostatic pockets. There is a continuous flow of oil that supplies these hydrostatic pockets with pressure. When additional grinding and acceleration forces load the pocket, the flow controller increases the pocket pressure and the flow in order to keep the gap constant. The extremely high damping ability eliminates all vibrations and makes it possible to grind faster and more precise with less tool wear than with any other mechanical bearing system. Rotary axes are designed in the same way. There is an inner and an outer shaft. The gap is pressurized by hydraulic oil, which serves as a bearing surface. They offer extreme stiffness and vibration damping.

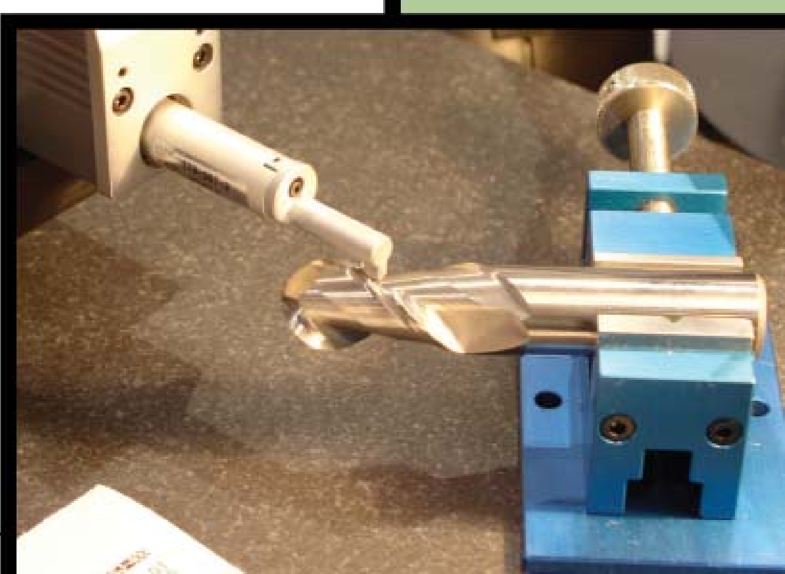

Photo 5 – Diamond Stylus on Workpiece

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Photo 6 – Slide Floats on Film of Oil

In tool grinding machines, fundamental vibrations and their harmonics are commonly amplified by the ball bearings in rotary axes.

Bearing In A Hydrostatic Grinding Spindle

Instead of ball or roller bearings found in a traditional spindle, the bearing in a hydrostatic spindle (Photo – 8a & 8b) consists of a thin film of pressurized oil, as in linear guides. There is no metallic contact between the shaft and the housing of the spindle therefore there is no friction and no spindle wear. The oil is brought to the spindle pockets (for example 6 pockets) by a pump under high pressure, through flow controllers. There is one flow controller for each hydrostatic pocket. The spindle shaft is suspended in the housing, separated by an oil film. When load is applied to the shaft (a grinding force for instance), the pressure in the pocket opposite to the force will increase in order to keep the gap constant and re-center the shaft, thus giving high stiffness. Concentricity of the arbor in rotation only depends on the arbor roundness. When manufacturing the arbor on a precise OD grinder, roundness of less than 20 millionth of an inch can be achieved (0.0005 mm). This extremely high precision of rotation will not deteriorate over time like in mechanical systems since there is no wear. In addition, because the film of oil is much thinner than a standard bearing, the spindle shaft of a hydrostatic spindle is much larger than the one using standard bearings (figure 3). That means that the stiffness of the hydrostatic spindle is approximately 6 times higher. High damping and stiffness, no wear and a perfectly concentric rotation of the spindle are the main advantages of a hydrostatic spindle. For a grinding machine, it means better surface finish and longer wheel life even with higher stock removal.

Recommended Automatic Stick Dressing

In order to maintain consistency during unattended operation, it is recommended to use an automatic sticking system. The grinding wheels that produce the most stock removal are the fluting and gashing wheel. On this system, these grinding wheels will automatically move over to the dressing stick in between grinding and plunge into the stick. Dressing sticks can be the silicon carbide or aluminum oxide type of abrasive.

Photo 7 – Bearings Replaced by Oil Pockets

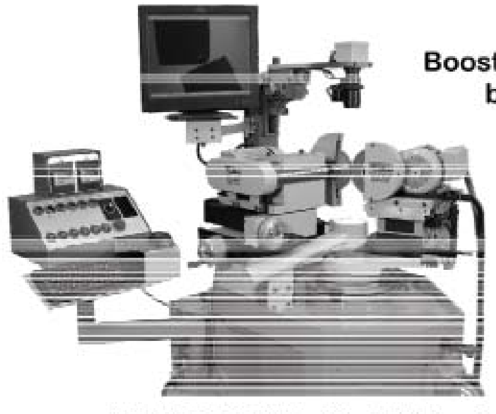
Tool Support Critical To Reduce Vibration

A further tool to reduce or eliminate vibration on the tool to be ground is to provide a tool support in two places. The tool blank is inserted into a V-block (Photo 11) so that it can rotate against the two angular surfaces of the V-block. These angular faces are 90 degrees to each other. A hydraulic pressure finger then rests on top of the blank, applying pressure to the rotating blank and holding it firmly against the V-block surfaces. This provides concentricity and reduces the purpose of the collet clamping to simply driving the blank. In addition, a movable steady rest can be placed under the grinding area to support the tool during the operations with most stock removal or other operations critical to the accuracy of the tool. A "fully hydrostatic" machine should always include hydraulic shank guidance of the workpiece as well as a hydraulic precision steady rest to support the blank while grinding and to take full advantage of the hydrostatic technology.

Application Improvements

Improved relief finish on the outside diameter of endmills is a proven and important benefit of "fully hydrostatic"

Diamond / CBN Wheel Truing & Dressing Machine



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grinding. Along with the highest possible concentricity and highest possible size tolerance, cutting tools generated on such a machine can appropriately be used in high-speed cutting, hard milling or any other high performance operation, giving excellent machining results in terms of time, finish and life. Flute face finish is probably the second most important aspect in the quality assessment of cutting tools. The level of the rake finish determines the degree of chip evacuation and ultimately the performance and life of the tool.

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Examples of grinding times in a real-life production environment:

- Carbide ballnose endmill, diameter - 20 mm, 2 teeth, cutting length 22 mm = 5 min.
- Carbide endmill, roughing profile, diameter - 22 mm, 4 teeth, cutting length 40 mm = 10 _ min.
- Carbide endmill 90 degree V-point, diameter - 20 mm, cutting length 50 mm = 11 min.
- Carbide ballnose endmill, diameter - 20 mm, 2 teeth, cutting length 40 mm = 8 min.
- Carbide endmill, diameter - 32 mm 2 teeth, cutting length 58 mm = 16 min.

Joint Effort Between Tool and Machine Tool Builder Paramount

It is unfair for a grinding machine builder to consistently blame diamond wheel manufacturers for the shortcomings of wheel performance or edge retention. There has to be a joint effort in making advancements. The hydrostatic tool grinders provide a platform of stiffness and damping, on which super abrasive wheels can excel and better cutting tools can be manufactured. ■

Photo 11 – Work Steady Test

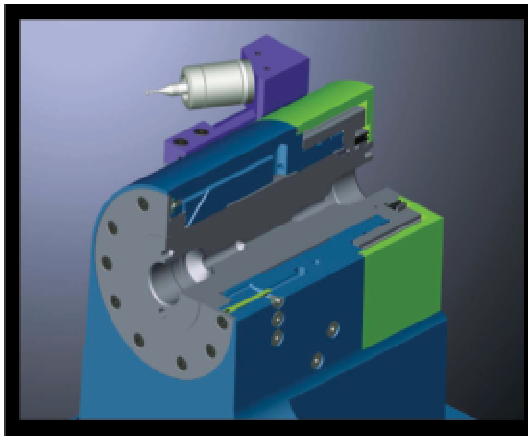

Photo 8a – Hydrostatic Spindle

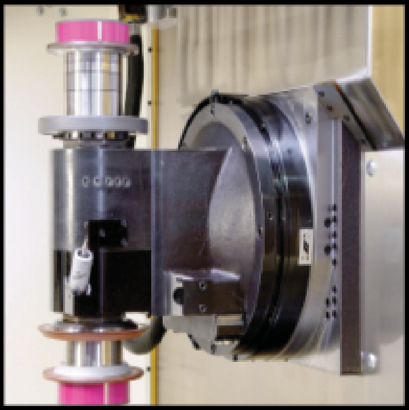

Photo 8b – Spindle & Rotary Axis

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When was your company established? __________
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List at least two business references, preferably one is an IDA member (name, company and address of each):
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Any company and/or individual classified as a superabrasive/ultra-hard material supplier, tool maker, machine tool builder, end user or related business with offices in the USA, Canada or Mexico is eligible in this category. Only one individual shall be designated by each member company as the IDA Delegate with voting and other privileges described in the By-Laws.

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The Industrial Diamond Association of America, Inc. **is a non-profit trade association and was incorporated on March 29, 1946 in the State of New York. It is the oldest and most prestigious association in the superabrasive/ultrahard materials industry. Activity and focus has evolved from natural diamond to superabrasives and most recently, to all ultrahard materials including CVD Diamond. Members include material suppliers, tool manufacturers, component producers, machine tool builders, end users, academia/research affiliates and other companies related to the research, manufacture, application, use and sales of superabrasives.**

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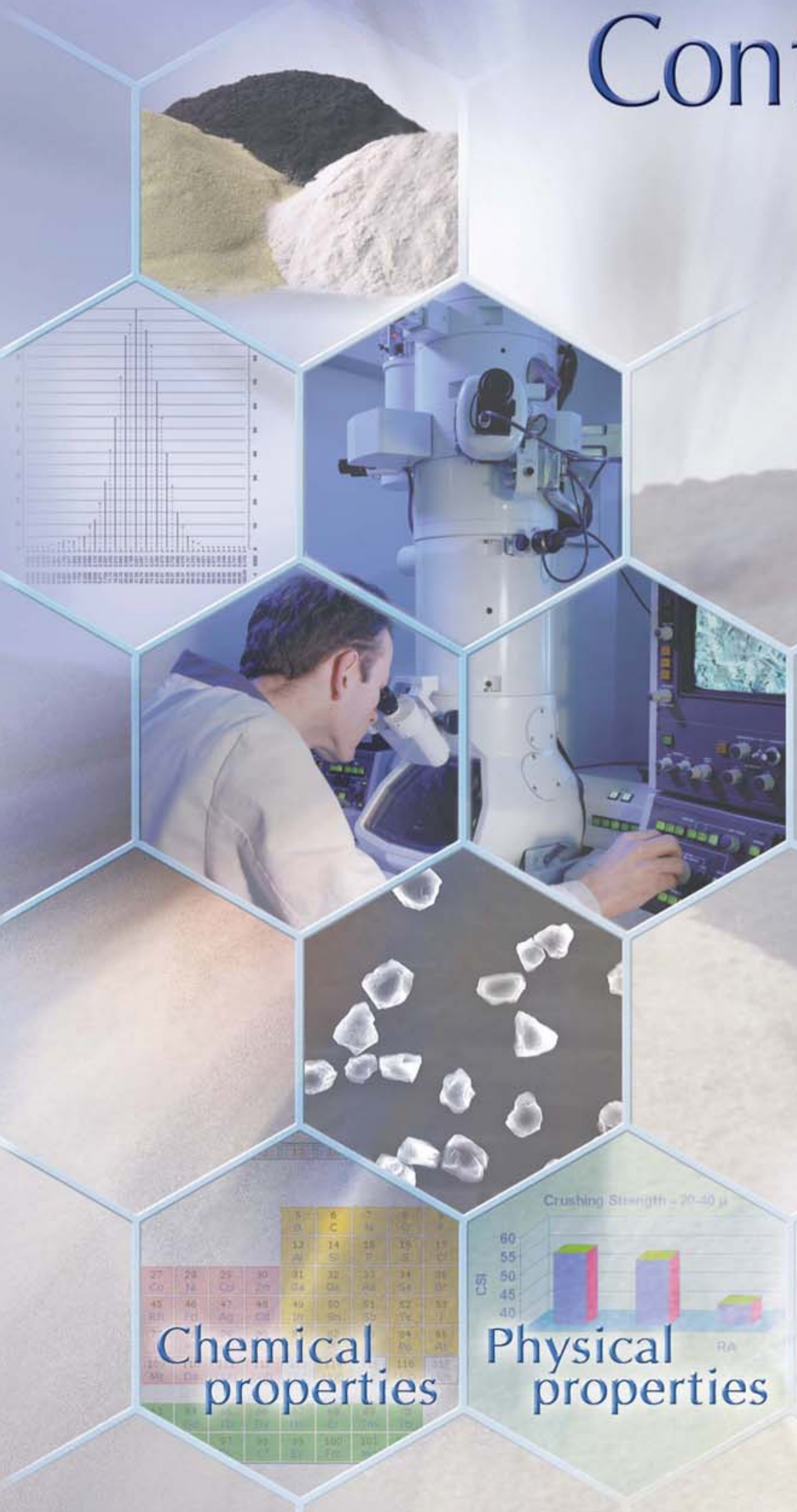

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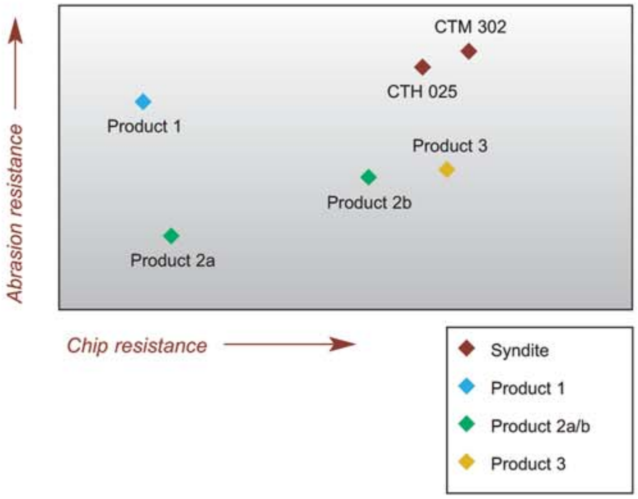
CTM 302 is ideal for the machining of non ferrous metals, like silicon-aluminum alloys and metal matrix composites.

ABRASION RESISTANCE vs CHIP RESISTANCE



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